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The mystery of the Marajoara: An ecological solution

by

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Abstract

For more than a century, the beautiful pottery from artificial mounds on the island of Marajó at the mouth of the Amazon has found its way into museums and private collections in Europe and North America, as well as Brazil. Since scientific investigations began in 1948, the discrepancy between the sophistication of the culture and the low agricultural potential of the environment has become increasingly apparent. Although claims that "Marajoara settlement pattern is urban in scale," that "the population could have been up to one million people," and that the ceramic art is "one of the most highly developed in the hemisphere" are extravagant, there is no doubt that the society maintained a relatively high level of complexity during nearly 1000 years in an environment that today supports only a sparse population dedicated mainly to cattle raising. Similar levels of cultural development elsewhere on the planet are sustained either by intensive agriculture or by unusually productive wild resources. Elimination of the former focuses attention on the latter and several new lines of evidence suggest that intensive exploitation of palm starch may be the solution to the mystery of the Marajoara.

Keywords: **Marajoara, archeology, Marajó Island, palm starch, Amazonia, climate change.**

Resumo

Durante mais de um século, a cerâmica formosa de colinas artificiais da Ilha de Marajó na embocadura do Amazonas tem chegado aos museus e coleções particulares na Europa, América do Norte, e também no Brasil. Desde que as investigações científicas iniciaram em 1948, a discrepância entre a sofisticação da cultura e o baixo potencial agrícola do meio ambiente têm se tornado cada vez mais aparente. Embora alegações que "o padrão de assentamento Marajoara é de escala urbana", que "a população poderia ter sido de um milhão de habitantes", e que a arte cerâmica é "uma das mais desenvolvidas do hemisfério" sejam exageradas, não há dúvidas que a sociedade mantinha um nível de complexidade relativamente alto durante quase 1000 anos num ambiente que hoje sustenta somente uma população esparsa dedicada principalmente

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à criação de gado. Níveis semelhantes de desenvolvimento cultural em outros locais do planeta são sustentados ou por agricultura intensiva ou por recursos naturais extraordinariamente produtivos. A eliminação do primeiro chama atenção para o segundo e várias novas linhas de evidência sugerem que a exploração intensiva de amido de palmeira pode ser a solução para o mistério Marajoara.

Introduction

Except for the antiquity of the peopling of the Americas, no topic generates more animosity among archeologists than the population density and cultural complexity in precolumbian Amazonia. One faction denies the existence of environmental limitations to sustainable intensive agriculture and cites the observations of early explorers and the existence of prehistoric habitation sites extending for kilometers in support of "vast regional polities...incorporating thousands of individuals into highly structured networks of alliance and exchange over which powerful elites held a dynastic dominance" (WHITEHEAD 1999: 383; also ROOSEVELT 1991, 1999; HECKENBERGER et al. 2000). The other faction cites abundant ecological, biological, edaphic, climatological, and ethnographic evidence for severe limitations to intensive exploitation and interprets the extensive archeological sites as the product of multiple reoccupation by small communities during hundreds of years (MEGGERS 1992, 1995, 1999; MILLER et al. 1992).

The only place where unequivocal evidence of cultural complexity has been found is the island of Marajó in the mouth of the Amazon. It is also the only place where severe environmental limitations to intensive agriculture have been scientifically documented. Explaining how the Marajoara were able to maintain a relatively high level of population density and sedentism during several hundred years under these circumstances is consequently a major challenge.

Marajoara culture

Numerous artificial earth mounds are distributed over the eastern half of the island of Marajó, which is dominated by savanna and gallery forest (Fig. 1). Since they were reported more than a century ago, about 30 have been described and/or tested unsystematically and collections of the elaborately decorated pottery have found their way to museums in Europe and North America, as well as in Brazil. The first stratigraphic excavations were conducted in 1949 at two sites near the western limit of the distribution, one consisting of three closely spaced mounds on the upper Anajás and the other of 20 mounds distributed in four clusters along the Igarapé Camutins (MEGGERS & EVANS 1957: 259-295). Ten mounds along the Goiapí and upper Camará southeast of Lago Ararí tested in 1963-65 provided the first radiocarbon dates (FIGUEIREDO & SIMÕES 1963; SIMÕES 1967). The most intensive excavations in a single mound were made during 1983 and 1985 at Teso dos Bichos in the same region (ROOSEVELT 1991). The only detailed descriptions of construction and content, as well as all the radiocarbon and thermoluminescent dates, are from these sites. The relative ages of the other mounds, the number in use contemporaneously, and the duration and intensity of occupation are unknown.

Extensive survey along the Amazon and its principal tributaries by participants of the Programa Nacional de Pesquisas Arqueológicas na Bacia Amazônica during the past three decades indicates that the Marajoara culture is unique among prehistoric Amazonian manifestations in several respects. It is the only one that constructed earth mounds for habitation and burial. A platform was erected to a level above high water and height was subsequently increased by occupation floors alternating with layers of sterile soil. On the upper Anajás, burial mounds measured between 121 and 255 m long and 6.4 to 10.0 m high during high water (Fig 2). Habitation mounds measured between 20 x 20 and 60 x 15 m in area and 3 to 6 m in height (MEGGERS & EVANS 1957). The concentration of burials and ritual objects and the high frequency of decorated sherds in the larger mounds suggest they served ceremonial as well as mortuary functions.

Although domestic pottery is plain, vessels for ceremonial and mortuary use are elaborately decorated by incising and excising on an unslipped, red, white, or double-slipped surface; by filling incisions and excisions with contrasting pigment, and by polychrome painting on a white slip (Fig. 2). Bowls often have excised designs on the exterior, incised designs on the rim, and painting on the interior. The complexity of the patterns, the skill in their execution, the standardization of the vessel shapes, and the existence of pairs of vessels with closely similar decoration are among features implying manufacture by specialized craftsmen. Differences in the treatment of the dead reflect social distinctions that are also implicit in the kinds and contexts of rare ceramic artifacts, such as stools, spoons, earplugs, figurines, and tangas.

The relative ceramic sequence is characterized by a decline in the frequency and quality of the most complex decorative techniques, by the replacement of large urns containing secondary burials with offerings by small jars containing cremations, and by a decrease in the abundance of specialized artifacts. Cultural simplification is likely to reflect a decline in population density, but this cannot be demonstrated without more extensive investigation.

The existence of most of the diagnostic Marajoara features in northwestern South America suggests an introduction from that general region, where environmental conditions are favorable for the intensive agriculture (MEGGERS 1992: 33-34; MEGGERS & EVANS 1957). Sites with pottery diagnostic of the Polychrome Tradition dominate the banks of the varzea after the beginning of the Christian Era, but the ceramic artifacts have not been reported. Burial urns have been found in some habitation sites, but no cemeteries have been encountered. The only other artificial mounds reported east of the Andes are on the llanos of Venezuela and northeastern Bolivia, where they are associated with different ceramic traditions.

The environment of Marajó Island

The most complex representative of the Polychrome Tradition occupies the region with the least favorable conditions for agriculture. Although Marajó is located in the mouth of the Amazon, it is not part of the várzea or alluvial flood plain. Rather, the eastern portion is a remnant of the ancient land mass formerly connecting the Guayana and Brazilian Shields, characterized by nutrient-poor soil (GUERRA & VALVERDE 1959: 212; SIOLI 1984: 155; SOMBROEK 1984: 529-530). A detailed assessment of agricultural potential by the Organization of American States recognized four categories of soil

based on drainage, effective depth, texture, fertility, and extent of erosion: I Good; II Average, III Restricted, and IV Unsuitable. None of the Marajó soils were identified as I or II. Twelve percent were classified as Type III, signifying that moderate returns can be expected during the first five years, after which productivity declines rapidly; these are limited to the eastern and southern coasts. Eighty-eight percent, including the region occupied by the Marajoara, were classified as Type IV, signifying that only low to very low returns can be obtained even during the first year (Fig. 3; OEA 1974: 8-11).

Soil deficiency is compounded by extreme seasonal climatic differences. Annual rainfall averaging 3000 mm and concentrated between January and July converts the center of the island into a freshwater lake 4 to 5 m deep (OEA 1974, map 7). During the dry season, by contrast, the soil bakes hard, Lago Ararí shrinks, and small streams cease to flow. In addition to lowering agricultural productivity, this situation substantially reduces the availability of fish and game on the island during several months each year.

Tangible evidence of the unsustainability even of the best soils for intensive agriculture is provided by the experience of the caboclo community of Praia Grande, population 111, located on the southeast coast of Marajó. Thirty years after its founding, the economy was judged extremely unstable because of low agricultural productivity, dependence on external income, and decreasing availability of cultivable land (MURRIETA et al. 1992). The question thus arises: how were the Marajoara able to survive, much less flourish, for nearly a millennium in the absence of a reliable agricultural subsistence base?

An alternative subsistence resource

The contrast between the dependence of millions of people in southeast Asia and Melanesia on starch obtained from wild stands of the sago palm (*Metroxylon sagu*) and the neglect of this resource today in Amazonia has been remarked by economic botanists (DAVIS 1988; JONES 1995; KAHN 1993; SMITH et al. 1992). Could exploitation of palms for starch be the solution to the Marajoara mystery? Although the evidence is circumstantial, it is suggestive.

Availability

Unlike eastern Marajó, the western half and adjacent small islands are low enough to be flooded by the Amazon. The increased soil fertility produced by the sediment-rich water is reflected in the high concentration and rapid growth of many species of palms with subsistence potential (ANDERSON 1988: 147). The burití, moriche or ité (*Mauritia flexuosa*) often occurs in dense almost pure stands up to 645 stems per hectare (GRAGSON 1995; MOORE Jr. 1973; BALICK 1988; Nat. Acad. Sci. 1975a). It is intensively exploited today throughout the lowlands both for inedible products and for fruit pulp, which contains 8-9% edible oil, 300 mg beta-carotene per 100 g, and more vitamin A than any other oil, as well as protein, fat, starch, and sugar (GRAGSON 1995; Nat. Acad. Sci. 1975a). Starch extracted from the trunk is the principal source of carbohydrate among several groups of hunter-gatherers. The average yield of 60 kg per trunk is comparable to that of an Indonesian species (RUDDLE et al. 1978, Table 3). The larvae of the palm borer, which develop in rotting trunks, are an important source

of fat (DUFOUR 1987, Table 2). The açai (*Euterpe oleracea*), the world's principal commercial source of palm hearts, occurs in wild stands estimated to occupy at least 10,000 km^2 in the Amazon estuary. Trees mature in 3-4 years, regenerate indefinitely, may have more than a dozen stems, can be harvested year-around, respond to selective pruning for palm heart by increasing fruit production on the remaining stems, and develop higher concentration with selective thinning. The fruits contain 1.25-4.34 % protein, 7.6-11.0 % fatty acids, and traces of Ca, P, Fe, and vitamins A and B (STRUDWICK & SOBEL 1988; ANDERSON 1988). Other trees with edible fruits include taperebá (*Spondias mombin*), ingá (*Inga spp.*), cacao (*Theobroma cacao*), cupuaçu (*Theobroma grandiflorum*), genipapo (*Genipa americana*), and papaya (*Cacarica papaya*).

Ethnographic evidence of indigenous use

Several indigenous hunter-gatherers on the fringes of Amazonia rely on palms for starch (Table 1). In the south, these include the Aché (Guayakí), Chamacoco, Toba, Lengua, and Mbayá in the Chaco, and the Bororo and Kaingang in southern Brazil (Fig. 4). The Aché cut open the trunk with an ax, crush the fiber by beating it with the butt of an ax or an old bow, pick it out, suck it dry or bind it in palm leaves, and take it to the camp. The moisture is squeezed out and the fiber is cooked alone or with meat, or it is sifted to separate the flour, which is eaten alone, mixed with meat, or made into balls and cooked. The Kaingang and Toba pound the pith in a mortar. In the north, starch consumption is reported among the Pumé (Yaruro) and Kariña on the western and eastern llanos of the Orinoco, the Warao in the Orinoco delta, and caboclos in the estuary of the Amazon (Fig. 4).

The most detailed description of starch processing is available for the Warao, who depend primarily on the burití palm (*Mauritia flexuosa*) and secondarily on the temiche palm (*Manicaria saccifera*). After the tree is felled, the bark is removed from the upper side to expose the fibrous interior. This is shredded with a hoe-like tool consisting of a narrow blade 40-60 cm long carved from the bark of a mature burití and attached at an angle to a wooden handle similar in length to the blade (Fig. 5a). The crushed pith is transferred to a strainer supported on four uprights over a trough ca 1 m long, cut from the trunk of another mature burití, and kneaded with water (Fig. 5b-c). The starch settles to the bottom of the trough, allowing the water to be scooped off. The starch can be preserved at least four months if kept moist and stored in baskets in the shade, making it available during the wet season when productivity is low and permitting its accumulation during several weeks in advance of festivals (SUAREZ 1966; WILBERT 1976; HEINEN & RUDDLE 1994). The similarity between the shredding tools used by the Warao and by groups in New Guinea and the Philippines is intriguing (Fig. 5d; SILLITOE 1998).

Archeological evidence

Tracing the use of palm starch backward in time is handicapped by the perishable nature of the product and the apparatus used for processing. However, semi-cylindrical (U-shaped) troughs similar in shape and size to those employed ethnographically have been encountered at Teso dos Bichos, a Marajoara habitation mound on the Rio Goiapí. They are about 1 m long and 50 cm wide, with slightly incurving margins that project 10-20 cm above the house floor (Fig. 6a-b). The 5-10 cm thick walls are made of hard-

baked ceramic-quality clay. Six to twelve adjacent troughs are often subdivided into groups of two or three by a ridge wide enough to walk on. One set is said to extend for 19 m (ROOSEVELT 1991: 211, 255, 286, 288-9). The interior was kept clean and repaired regularly. Although the author identifies them as stoves, this function seems incompatible with the rarity of carbonized remains and charcoal both inside and outside and with their contiguity, which impedes access except at the ends. The shape and size of these features are comparable to the wooden troughs used for processing palm starch by the Warao (Fig 6c), as well as in New Guinea (SILLITOE 1998, Pl.2.2) and the Philippines, where they frequently occur in pairs and where the strainer is placed at the end rather than the center (RUDDLE et al. 1978, Figs. 16c, 16d). A charred post encountered adjacent to one of the "stoves" may be analogous to the supports for the strainers used by the Warao. The number of troughs and the failure to encounter similar constructions in other Marajoara mounds that have been examined suggests that Teso dos Bichos may have served as a center for mass processing of starch, such as exists today in some parts of southeast Asia. This would obviate the need to sacrifice trunks to make troughs in the field (RUDDLE et al. 1978: 84).

Another intriguing transpacific similarity is an unusually shaped stone artifact known both in Colombia and in New Guinea and Australia as a "waisted" hoe or ax, consisting of a blunt, circular or slightly ovoid blade and an abbreviated butt set off by an indentation or groove. Examples reported from various parts of the Cauca Valley of Colombia date between 9600 and 7800 BP, when phytolith analysis implies the existence of a plant formation similar to a morichal (Fig. 7a; HERRERA et al. 1999), and from gold and tin-bearing alluvial deposits in Amazonia considered to be of late Pleistocene age (VEIGA 1991). A more symmetrical example has been reported from Surinam (VERSTEEG & BUBBERMAN 1992, Fig. 28). The waisted axes encountered in streams in Papua New Guinea and Australia are also considered to date from the late Pleistocene (MULVANEY & KAMMINGA 1999: 218-219). They are more crudely shaped than those in South America and weigh between 1.9 and 2.6 kilos (Fig. 7b). Like their New World counterparts, however, they are blunt, making them inefficient tools for forest clearance, but "suitable ... for some forms of more direct food procurement; e.g. in most stages of sago production" (GROUBE 1989: 297). The apparent restriction of the South American examples to pre-agricultural contexts suggests they may have had a similar function. A "celt-type" stone ax is still used by the Aché for extracting palm products (HILL & HURTADO 1999).

Climatic considerations

The suggestion that dessication of the swamps along the coast of Guyana between 4000 and 3500 BP reduced the availability of palm starch and forced increasing dependence on manioc (WILLIAMS 1992: 246) provides a possible analogy for the demise of the Marajoara. A pollen core from Lago Ararí in the center of the Marajoara distribution attests to the expansion of savanna vegetation ca 1500, 1000, 700, and 500 BP, when much of Amazonia experienced episodes of severe drought as a consequence of mega episodes of El Niño (ABSY 1985, Fig. 4.9; MEGGERS 1994). Existing radiocarbon and thermoluminescent dates place the inception of the Marajoara ca 1500 BP, when more humid conditions are implied by the increase in arboreal vegetation. The 1000 BP drought produced a second advance of savanna. The potential magnitude of the rainfall deficit is suggested by the impact of the brief 1997 episode of El Niño, which caused

a decrease of 75% at Altamira, 80% at Marabá, and 50% at Belém (DINIZ 1998). The presence of a layer of eolian sand 8 to 20 cm thick over the surface of Teso dos Bichos testifies to the magnitude of the dessication in the vicinity of the site at the time of abandonment (ROOSEVELT 1991: 169, 266, 270).

The negative impact of local drought on the abundance of palms may have been enhanced by lower discharge of the Amazon. The normal difference between high and low water between the Jarí and eastern Marajó is 2 to 4 m (VITAL & STATTEGGER 2000: 318). Pollen profiles from the floodplain east of Manaus suggest that the water level was lower between ca 1000 and 700 BP than during the previous millennium (Fig. 8; ABSY 1983). This interpretation is compatible with measurements at Obidos during the relatively mild 1983 episode of El Niño, which recorded a 16 % decrease in annual discharge (GUYOT et al. 1998; RICHEY et al. 1989). During one day in February, the discharge of the Trombetas dropped to 47 m3s-1 compared with the long-term average of 2100 m3s-1 (MOLION & MORAES 1987). In Papua New Guinea and Irian Jaya, the shortage of fresh water made it difficult or impossible to produce sago during the 1997-98 ENSO and the same inhibition would have existed on eastern Marajó during precolumbian episodes (ALLEN 2000: 109; BALLARD 2000: 133). Whatever management practices were in effect to maximize productivity may have retarded the rate of depletion. In any case, the Marajoara appear to have persisted until the 700 BP drought, when they were assimilated or replaced by the Aruã.

Discussion

To argue that eastern Marajó is varzea (ROOSEVELT 1991: 20), in spite of abundant evidence to the contrary, evades the question of how the Marajoara were able to flourish for several hundred years in an environment unsuitable even for slash-and-burn cultivation. The incongruity is accentuated by the absence of evidence for similar social complexity in sites of the Polychrome Tradition along the banks of the Amazon and its white-water tributaries, where agricultural conditions are considered relatively favorable.

Several kinds of circumstantial evidence suggest that the solution to the mystery lies in the intensive exploitation of palms for starch. These are: (1) the high density of suitable palms on the western half of Marajó; (2) the reliance on palm starch by the Warao in the adjacent delta of the Orinoco; (3) the similarity of the wooden troughs used in starch processing by the Warao to the pottery "stoves" encountered in Teso dos Bichos; (4) the antiquity of palm-starch exploitation in the lowlands, implied by the disjunct distribution of surviving practitioners and the early Holocene dates for waisted axes possibly used for shredding the fiber, and (5) the vulnerability of palms to repeated episodes of severe drought, which can account for the Marajoara decline,

The Amazon estuary has been evaluated as "eminently suited to the demands of extractivism [which] can be sustainable when integrated with long-term forest management" (ANDERSON 1988: 147). Useful species are both concentrated and highly productive. Many are extremely fast growing, respond to management practices by the present inhabitants, tolerate short-term harvest, and recover rapidly from disturbance (ANDERSON 1990). It has also been shown that sago production is less labor intensive than cereal cultivation, requiring ca 150 man-hours to produce a million calories, compared to ca 180 for paddy rice and 210 for maize (RUDDLE et al. 1978, Fig. 17).

The contrast between the dependence of millions of people in southeast Asia and Melanesia on starch obtained from the trunk of the wild sago palm (*Metroxylon sagu*) and the neglect of this resource in Amazonia today has been remarked by economic botanists (DAVIS 1988; JONES 1995; KAHN 1933; SMITH et al. 1992). Although the evidence is circumstantial, the Marajoara case suggests that palm starch may have been more important in prehistoric Amazonia than we have suspected prior to the domestication of manioc.

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Table 1: Indigenous South American groups that depend on palm starch.

Group	Location	Species	Source
Aché (Guayaki)	E. Paraguay	*Cocos romanazoffiana* *Arecastrum romanzoffianum*	HAWKES, HILL & O'CONNELL 1982 DENEVAN & SCHWEREN 1968, RUDDLE et al. 1978
Bororo	Mato Grosso	Unidentified	COOK 1907, RUDDLE et al. 1978
Chamacoco	Chaco	Carandaipé palm	MÉTRAUX 1946: 248
Kaingang	S. Brazil	Unidentified	MÉTRAUX 1948: 82
Kariña	E. Orinoco	*Mauritia flexuosa*	CIVRIEUX 1957
Lengua	Chaco	*Copernicia cerifera*	WILBERT 1976
Mbayá	N. Chaco	*Acrocomia* sp. *Cocos paraguayensis*	MÉTRAUX 1946: 247-8, HERBERTS 1998: 138-143
Pumé (Yaruro)	W. Orinoco	*Mauritia flexuosa*	GRAGSON 1995, ORTEGA 1994-6
Toba	Chaco	*Copernicia cerifera*	WILBERT 1976
Warao	Orinoco delta	*Mauritia flexuosa* *Manicaria saccifera*	WILBERT 1976
Caboclos	Amazon estuary	*Mauritia flexuosa*	HIROAKA 1999

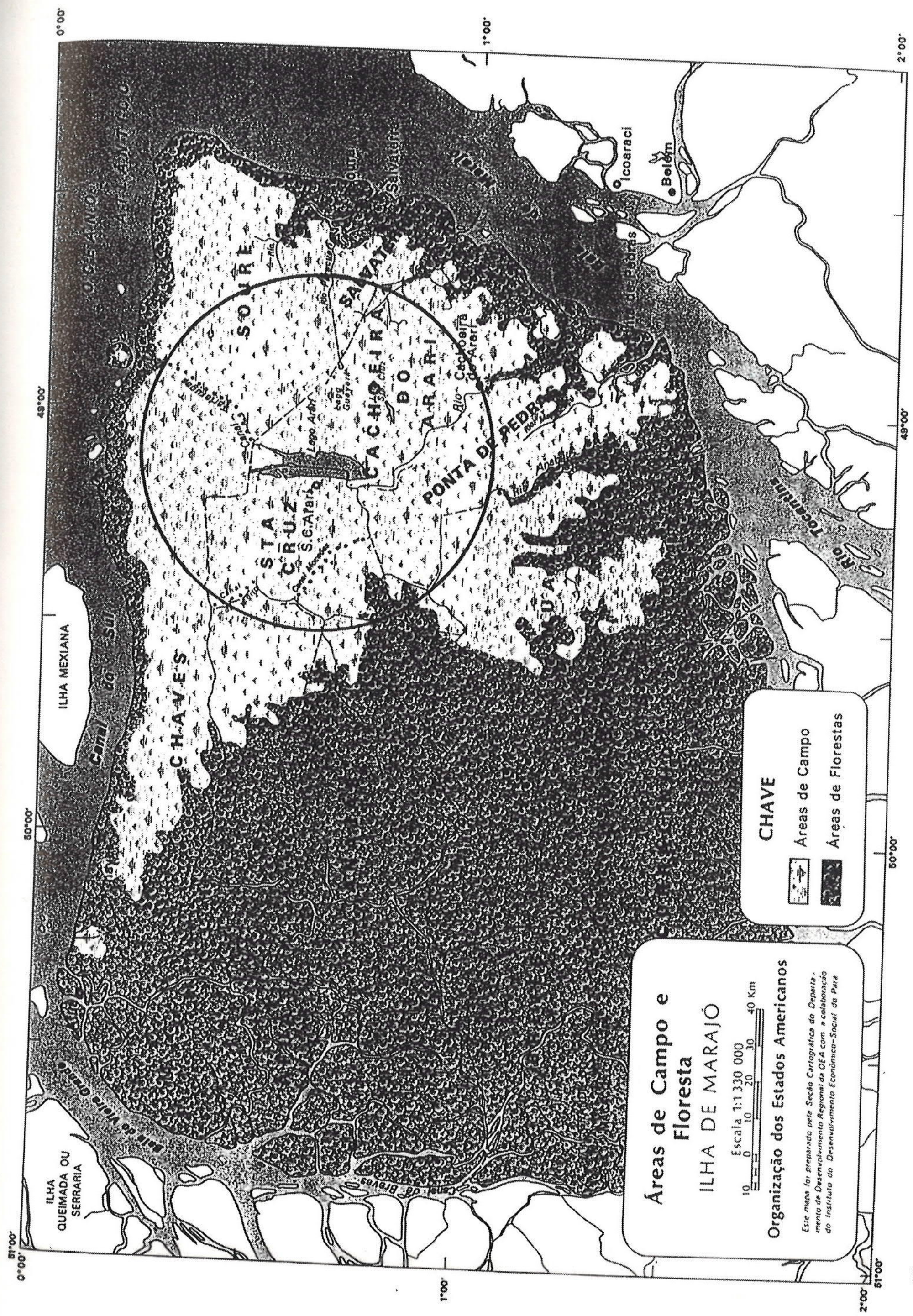

Fig. 1:
Marajó Island, showing the distribution of savanna and forest vegetation and the general area occupied by the Marajoara culture (after OEA 1974, map 2).

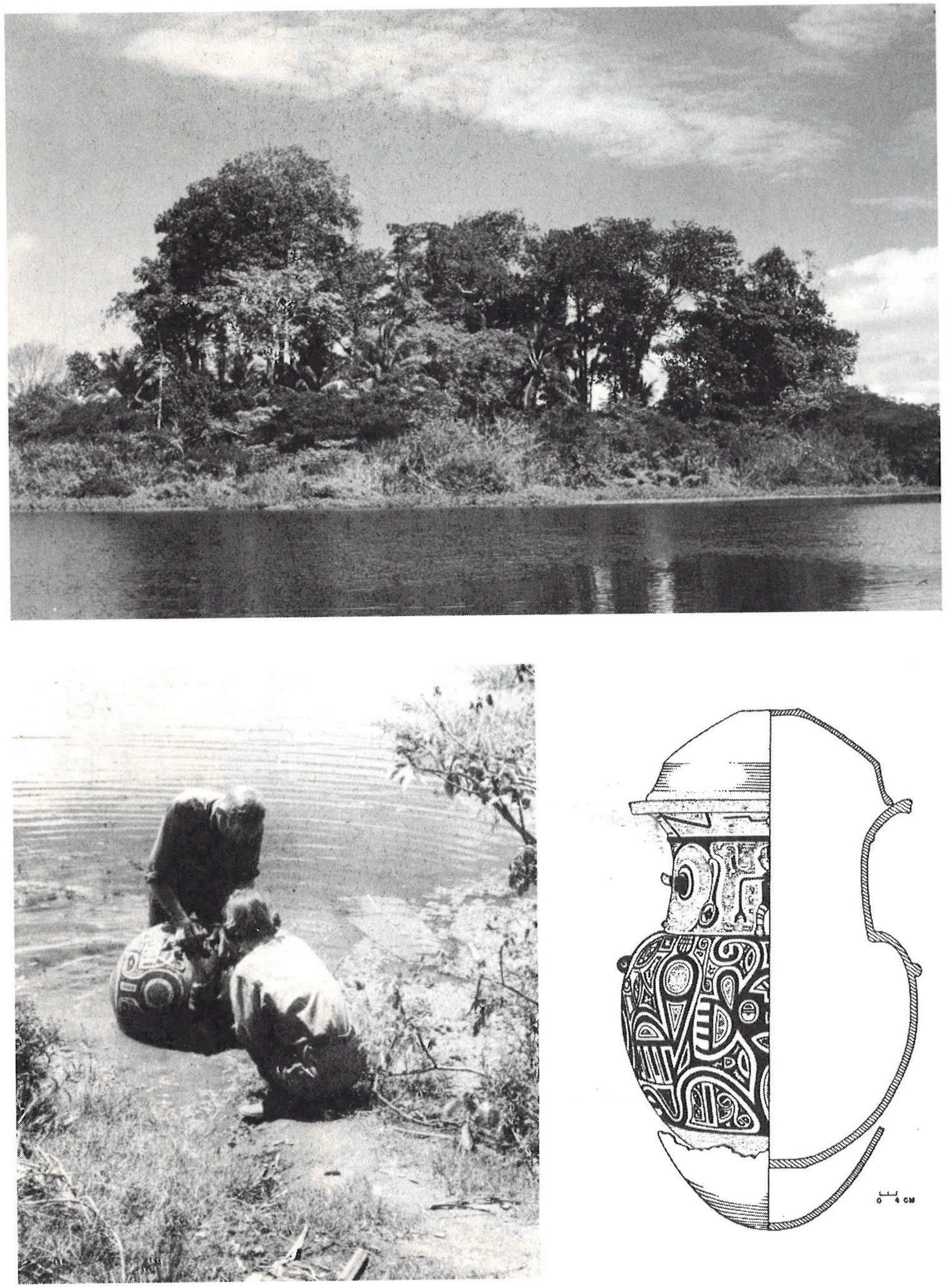

Fig. 2:
The Marajoara burial mound of Guajará at the height of the rainy season and a polychrome burial urn excavated in 1949, now in the Museu Paraense Emílio Goeldi.

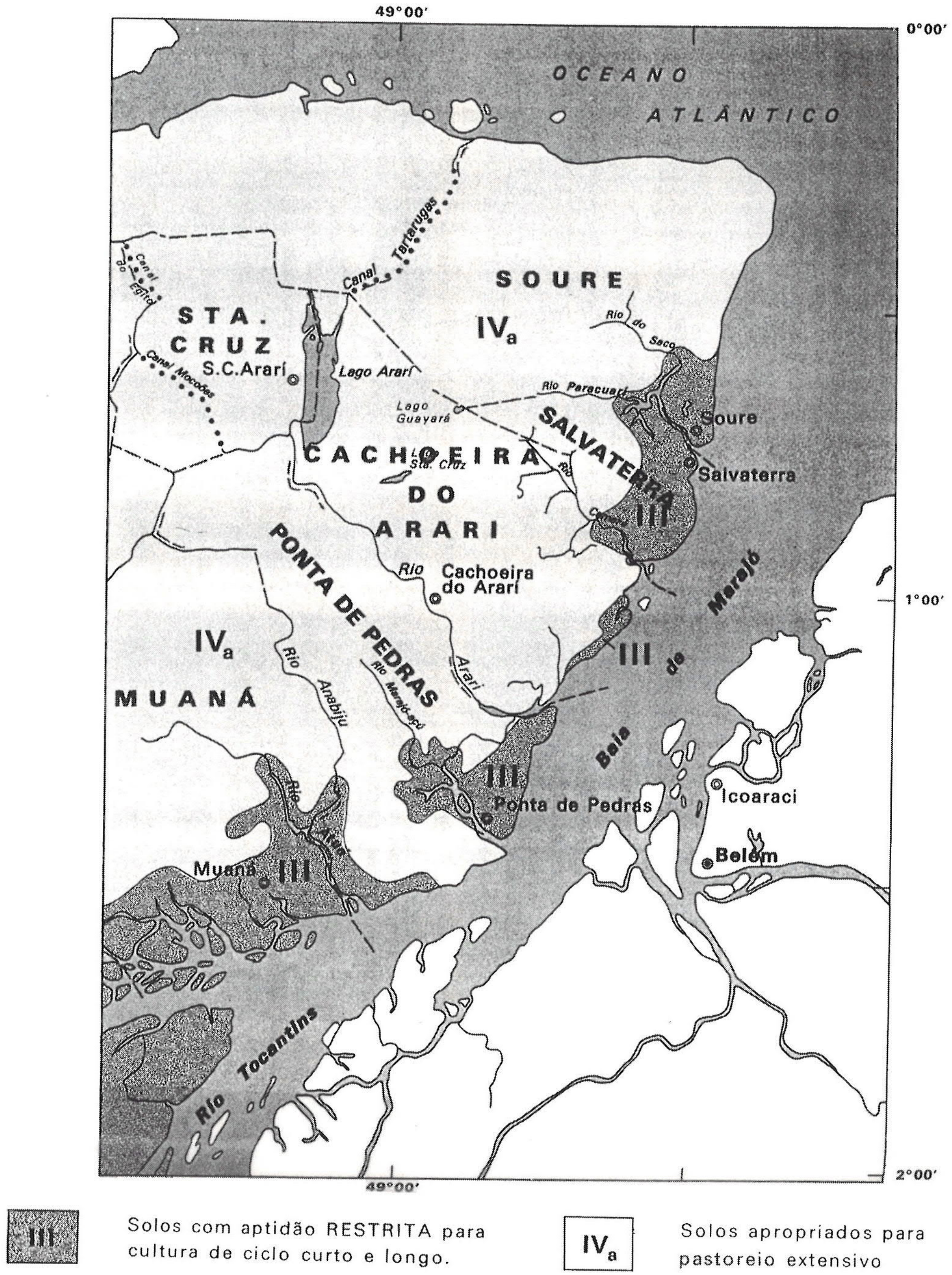

Fig. 3:
Distribution of soils on eastern Marajó rated III: Restricted and IV: Unsuitable for agriculture (after OEA 1974, map 4).

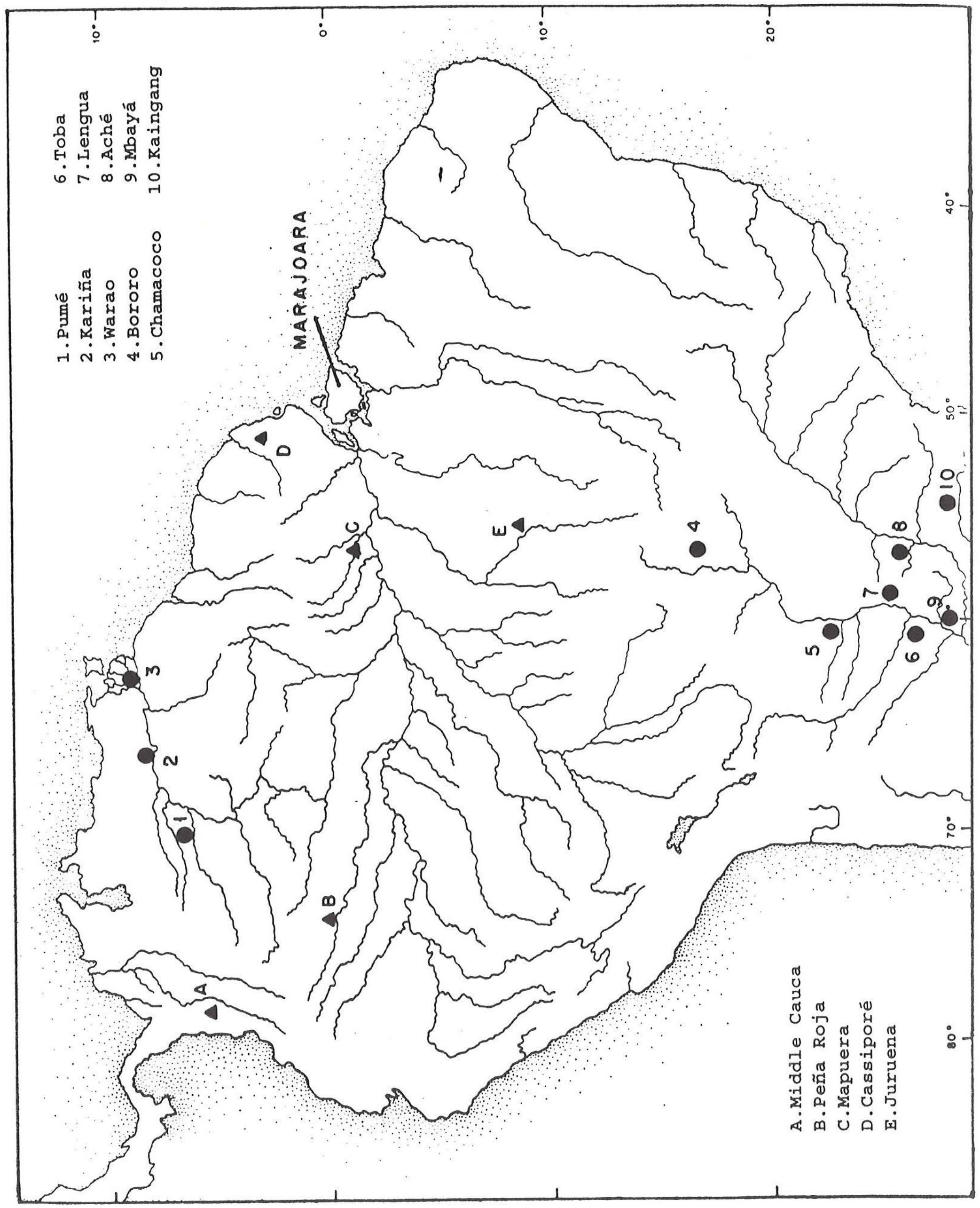

Fig. 4:
Map of South America showing the locations of surviving South American indigenous groups that process starch from palm trunks and the archeological distribution of "waisted" axes.

Fig. 5:
Palm starch processing by the Warao at the mouth of the Orinoco, Venezuela (**a-c**) and the Korowai in New Guinea (**d**). **a**: shredding pith; **b**: transferring the pith to the strainer; **c**: kneading the pith with water; **d**: shredding pith. Note the similarity of the shredding tools. (**a-c**: courtesy of J. WILBERT; **d**: after SILLITOE 1998, plate 2.1).

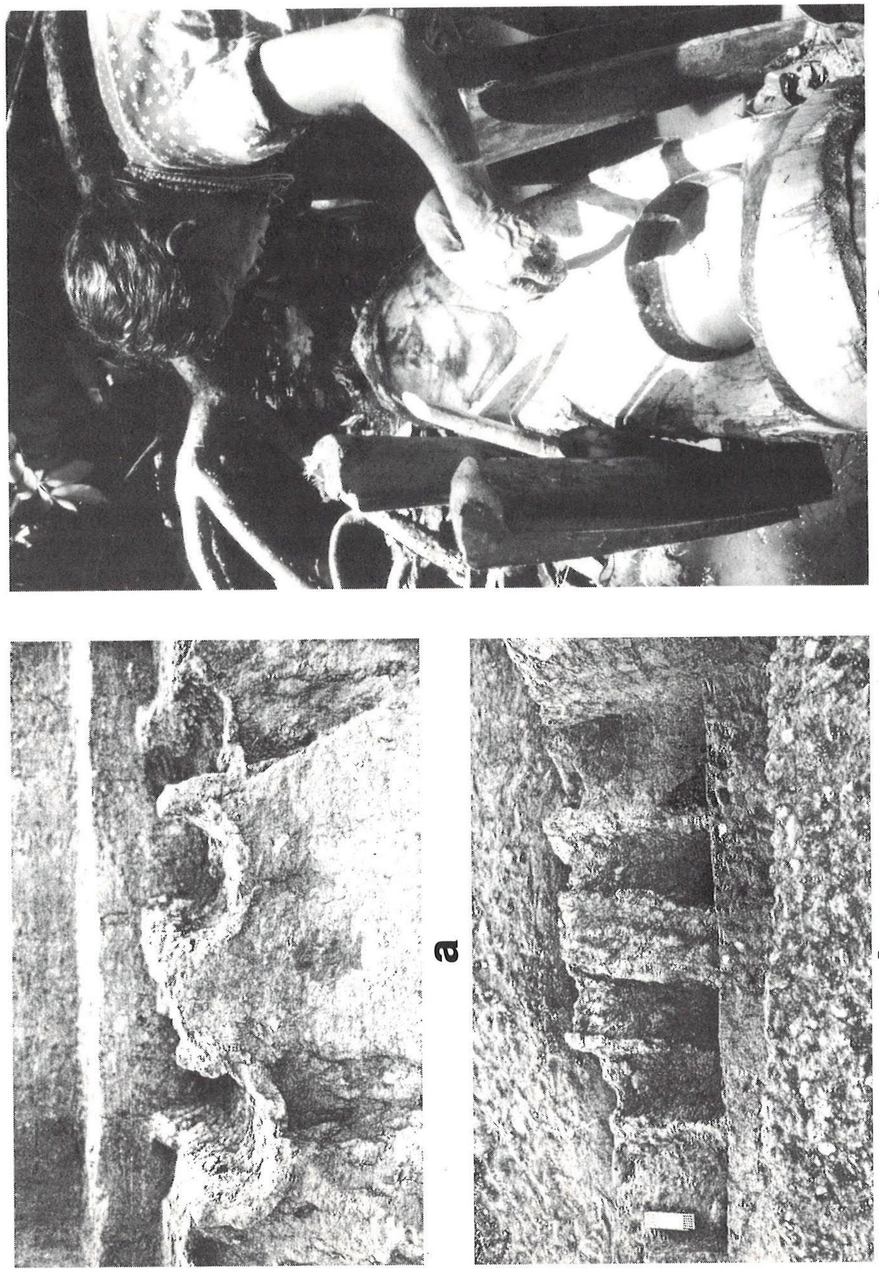

Fig. 6:
Similarity between the semi-cylindrical troughs lined with baked clay in the Marajoara site of Teso dos Bichos and a wooden trough used by the Warao for collecting palm starch (**a**: after ROOSEVELT 1991; **b**: courtesy of J. WILBERT).

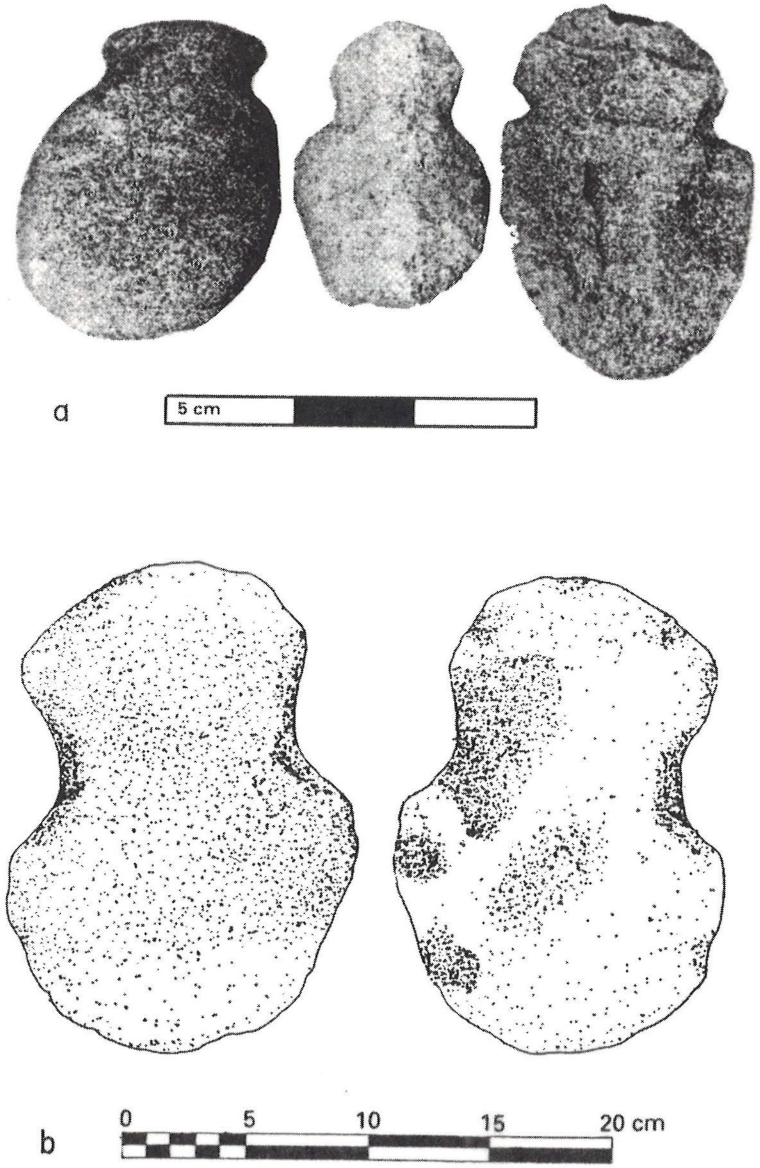

Fig. 7:
"Waisted" axes possibly used for processing palm starch. **a**: Middle Cauca Valley, Colombia; **b**: Huon Peninsula, Papua New Guinea (**a**: after HERRERA et al. 1999; **b**: after GROUBE 1989).

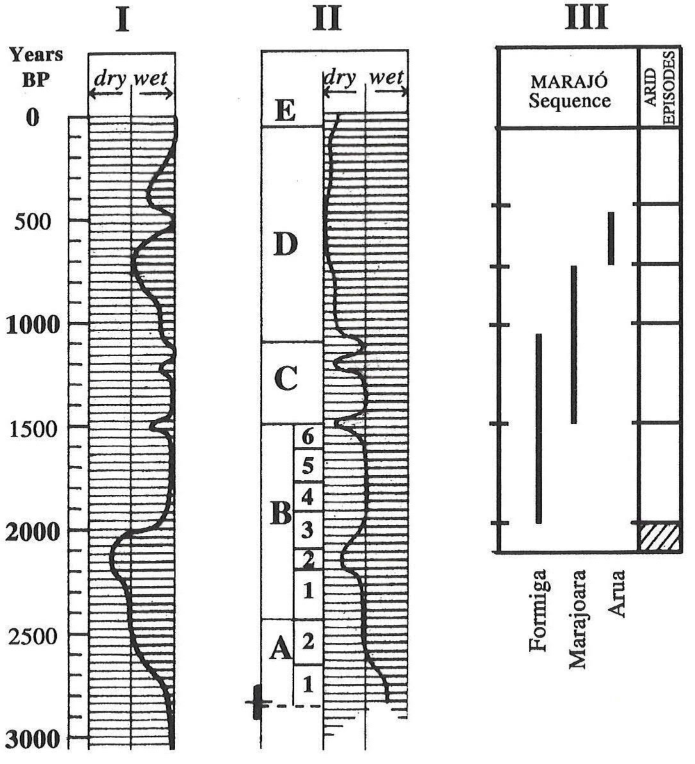

Fig. 8:
Correlation between fluctuations in the water level of the Amazon during the past 3000 years inferred from changes in pollen in sediment samples from the flood plain at Costa da Terra Nova east of Manaus (**II**) and replacements in the archeological sequence on Marajó (**III**). The arrival of the Marajoara following the mega-Niño event ca 1500 BP coincides with relatively wet conditions in the generalized curve for the lowlands (**I**). The inception of drier conditions after ca 1000 BP correlates with the disappearance of the Formiga Phase and may have initiated the decline of the Marajoara. Their replacement by the Aruã ca 700 BP correlates with another mega-Niño event. The pollen record from Costa da Terra Nova suggests lower water level on the Amazon after ca 1000 BP, which might have contributed to a reduction in the density of palms on western Marajó, creating subsistence stress for the Marajoara. **I**: Generalized curve for the Amazon Basin; **II**: Inferred fluctuations at Costa da Terra Nova; **III**: Sequence of archeological phases on Marajó; A-D, local pollen zones (after ABSY 1982 and MEGGERS 1994).